Amphioxus in Old Tampa Bay, Florida

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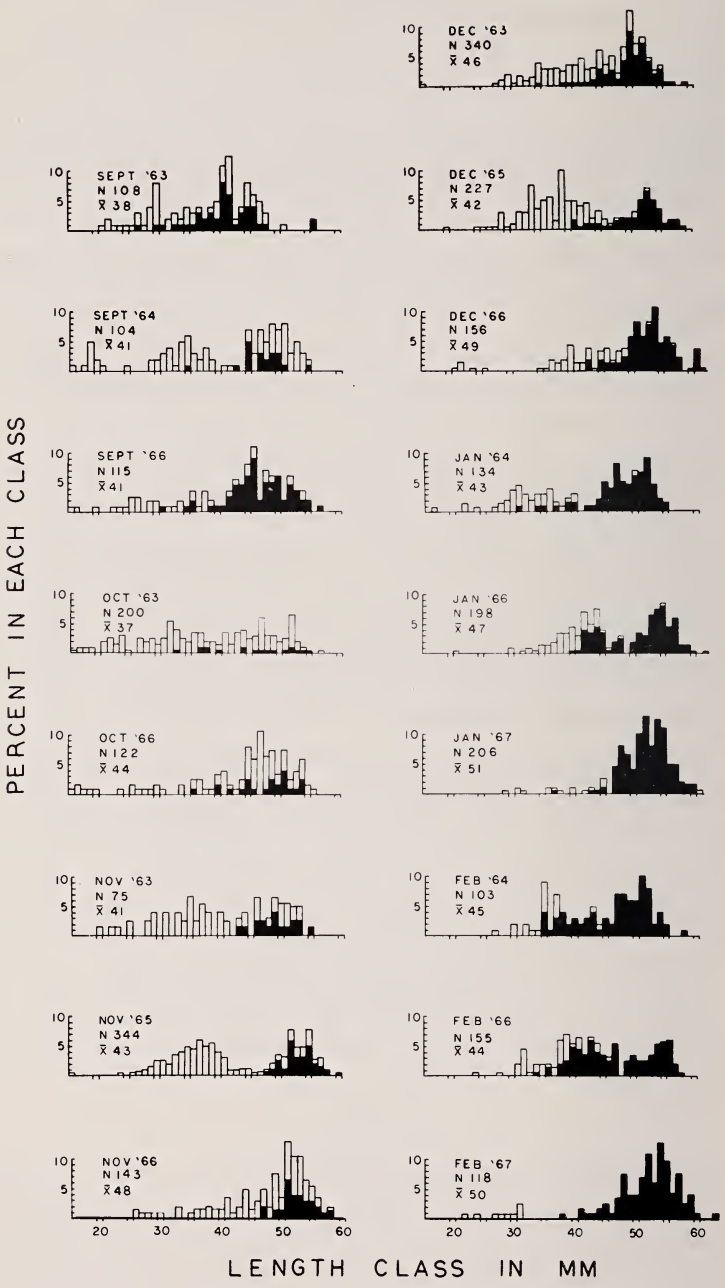
The presence of the amphioxus, *Branchiostoma caribaeum*, in Tampa Bay was documented in 1890 when A. A. Wright collected them near Port Tampa at the mouth of Old Tampa Bay. Wright (1890) reported that specimens were abundant and easily secured. Other workers subsequently collected specimens in the area. Recently E. L. Pierce (1965) again affirmed their great abundance by reporting an average of 183 per liter of sand near Gandy Bridge. Boschung and Gunter (1962) and E. L. Pierce (1965) investigated *B. caribaeum* from other coastal areas of Florida emphasizing the taxonomy and distribution of the organism.

The anatomy and embryology of *Branchiostoma* have been thoroughly studied, but little is known concerning its ecology. The only detailed ecological study on the group was made by J. E. Webb (1958) and by Webb and Hill (1958) on the African amphioxus *Branchiostoma nigeriense*. Their publication describes its distribution in a large lagoon, the duration of its embryonic and larval stages, growth rates in the adult, salinity tolerance, and relationship to the substrate. They did not emphasize population characteristics of *B. nigeriense*.

The purpose of the study described here was to determine some of the basic attributes of amphioxus populations in Old Tampa Bay. The study was designed specifically to determine whether *B. caribaeum* had a definite spawning time or spawned throughout the year, how the population changed seasonally as reflected by changes in length frequencies and sexual state; whether age classes could be distinguished by the length frequency data; and some idea of the density of the population. The study was conducted from September 1963 through August 1967. The months during which samples were collected are indicated on Figs. 1 and 2.

Methods

The site of the investigation was Old Tampa Bay, an estuary on the west coast of Florida. This is a shallow body of water, with greatest depth of 16 feet, and about 14 nautical miles long by 7 miles wide. Salinity fluctuates between 18-24 parts per thousand,


DEC '63
N 340
X̄ 46
SEPT '63
N 108
X̄ 38
DEC '65
N 227
X̄ 42
SEPT '64
N 104
X̄ 41
DEC '66
N 156
X̄ 49
SEPT '66
N 115
X̄ 41
JAN '64
N 134
X̄ 43
OCT '63
N 200
X̄ 37
JAN '66
N 198
X̄ 47
OCT '66
N 122
X̄ 44
JAN '67
N 206
X̄ 51
NOV '63
N 75
X̄ 41
FEB '64
N 103
X̄ 45
NOV '65
N 344
X̄ 43
FEB '66
N 155
X̄ 44
NOV '66
N 143
X̄ 48
FEB '67
N 118
X̄ 50
10
5
20
30
40
50
60
PERCENT IN EACH CLASS
LENGTH CLASS IN MM

and the area is subject to daily tidal fluctuations. The Bay contains a number of sandy bottom areas suitable for amphioxus, interspersed with mud bottom areas and grass flats not inhabited by the animal.

Old Tampa Bay has been severely changed by man's activities, mainly by dredging and the construction of three roadways across it. In addition the area receives heavy recreational use. Despite this drastic alteration of the environment, amphioxus remains abundant in Tampa Bay, even as Wright (1890) and Andrews (1893) reported many decades ago.

A general sampling survey of the Bay area indicated that a sandy strip along the southeast side of Courtney Campbell Parkway maintained a large population of lancelets and was convenient for sampling purposes. This area served as the collecting station for the study. It was usually visited at low tide to facilitate sampling. Approximately five liters of sand were shoveled into a plastic bucket and carried to the beach for screening. Small amounts of the sand were placed on the screen and washed with sea water. Specimens were picked from the screen and placed in gallon jars of water. Two sieving devices were used, a brass testing sieve with 0.98 mm mesh openings, and a home-made sieve constructed with two layers of plastic screen having the equivalent of 1 mm openings. The latter device was easier to use and retained the smaller specimens about as well as did the brass screen. Both were used throughout the study.

Specimens obtained in the manner described above, about twenty per jar, were returned immediately to the University and placed in an air-conditioned laboratory. With no additional attention these specimens survived for three to five weeks in the summer and for several months if collected in winter.

The individuals constituting each sample (100 or more) were measured while alive by placing them in a petri dish resting on a plastic, transparent millimeter ruler. Using a low magnification dissecting microscope, the specimen's total length (from tip of the

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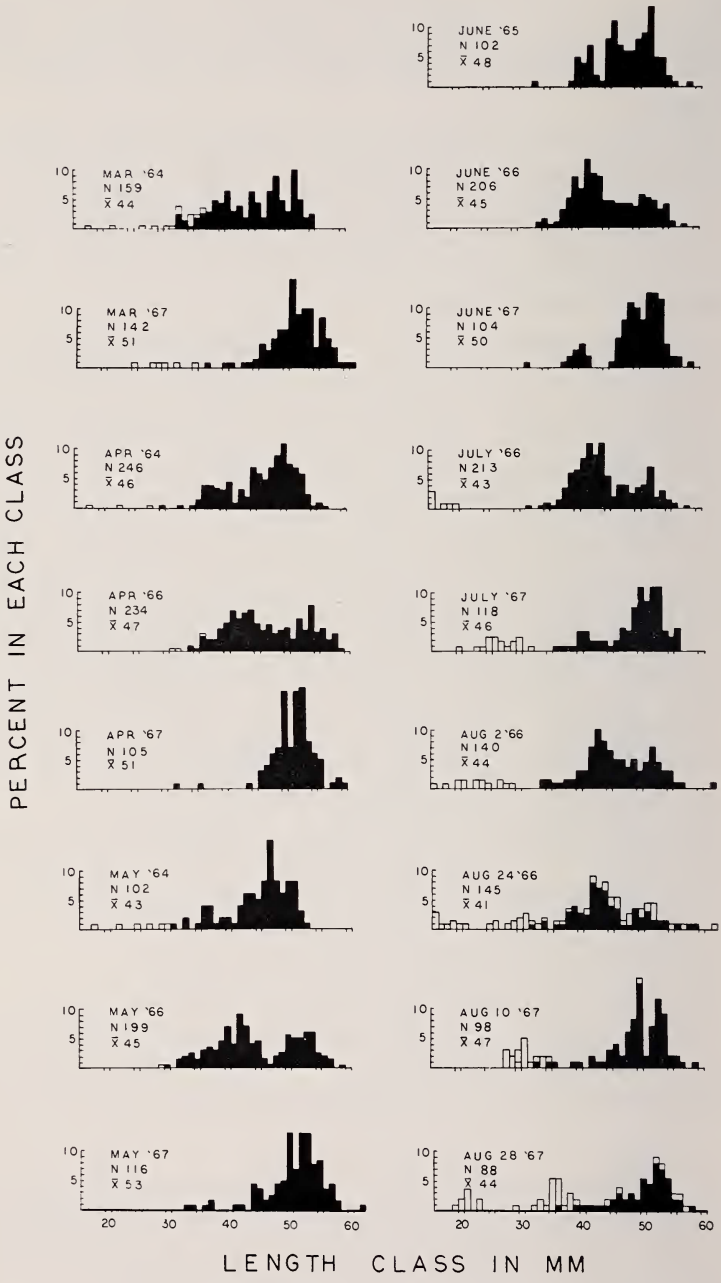
Fig. 1. Monthly histograms for amphioxus samples collected from September through February. Open bars represent individuals without gonads (less than 30 mm in length), or else containing empty gonads. Solid bars represent males and females with full gonads. Number of individuals in the sample and the mean length of members comprising the sample are given.


PERCENT IN EACH CLASS
MAR '64 N 159 X̄ 44
MAR '67 N 142 X̄ 51
APR '64 N 246 X̄ 46
APR '66 N 234 X̄ 47
APR '67 N 105 X̄ 51
MAY '64 N 102 X̄ 43
MAY '66 N 199 X̄ 45
MAY '67 N 116 X̄ 53
JUNE '65 N 102 X̄ 48
JUNE '66 N 206 X̄ 45
JUNE '67 N 104 X̄ 50
JULY '66 N 213 X̄ 43
JULY '67 N 118 X̄ 46
AUG 2 '66 N 140 X̄ 44
AUG 24 '66 N 145 X̄ 41
AUG 10 '67 N 98 X̄ 47
AUG 28 '67 N 88 X̄ 44
10
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LENGTH CLASS IN MM

rostrum to tip of the caudal fin) was recorded to the nearest millimeter. At the same time the specimen's sex and degree of sexual maturity (full, empty, or partially empty gonads) was observed and recorded. The use of live specimens is a basic and crucial aspect of the study because the animal is semi-transparent while alive but becomes opaque when preserved. The opacity of the preserved specimens makes sex determination or determination of sexual development difficult. On living specimens these conditions are obvious at a glance.

The length frequency data and data concerning the sexual state of the individuals in a sample are summarized on the length-frequency histograms in Figs. 1-2. Conclusions concerning the population characteristics of *B. caribaeum* were based primarily on these histograms.

SPAWNING

As shown by the histogram data, spawning for *B. caribaeum* in Old Tampa Bay begins in late August. At this time large adults begin to appear with discharged gonads as shown in August 24, 1966, and August 28, 1967 (Fig. 2). This becomes even more evident during September (Fig. 1) and continues into December. In addition, some amount of spawning evidently occurs throughout the year because at least a few small specimens (less than 20 mm in length) are found nearly every month of the year.

Sexual maturity in *B. caribaeum* occurs at 30 mm in length. Specimens smaller than this often contained developing gonads, but the smallest undoubtedly mature individuals were 30 mm or longer.

Why reproductive activity begins in late summer is not clearly indicated since there are no sharp changes in salinity, temperature, light intensity, or tides at this time to act as a trigger. Carlisle (1951) found that the ascidians *Ciona* and *Phallesia* spawned when fed eggs and sperm of their own species. It is tempting to hypothesize this sort of mechanism operating in amphioxus. That

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Fig. 2. Monthly histograms for amphioxus samples collected from December through August. Open bars represent individuals without gonads (less than 30 mm in length), or else containing empty gonads. Solid bars represent males and females with full gonads. Number of individuals in the sample and the mean length of members comprising the sample are given.

is, as a portion of the population reaches sexual maturity during the summer, they spontaneously release eggs and sperm. These products are unavoidably ingested by other mature or near mature individuals to bring about a large scale or simultaneous spawning such as recorded for September (Fig. 1). Unfortunately, evidence available at this time does not support the hypothesis. As quoted from Bone (1958), "Ripe adults were dissected and the eggs and sperm mixed in Boveri dishes, or sperm was placed in the water containing ripe females and vice versa, but these experiments yielded no results."

From September through December (Fig. 1) the population consists predominately of members which have either discharged their sexual products or are in the process of developing gonads.

After December a steady increase in individuals with full gonads is noted. This build-up continues through the spring and summer until the August spawning.

Age Classes

A close examination of the histograms indicates that three age groups probably make up the population in Tampa Bay. This is especially evident in samples for September 1964, November 1963, December 1966, January 1964, February 1966, May 1964, July 1966 and 1967, and August 1966 and 1967. The following age classes are proposed on this basis:

1) *First year class.* This group consists of individuals hatched in late summer or early fall. They are evidently planktonic at first and start appearing in the sand when they are 10-15 mm in length. Specimens as small as 10 mm could probably wriggle through the openings of the sieve used in the study. However, samples of sand, treated with formalin, were carefully searched without success for specimens smaller than 10 mm. Some members probably attain 30 mm total length and sexual maturity during the year. Members of this age group are especially noticeable on histograms for September, October, and November (Fig. 1).

2) *Second year class.* This age group averages around 35 mm in the fall as shown on some of the September through December graphs. This portion of the population grows and matures sexually until it averages 40-45 mm in length during the summer, May-August (Fig. 2).

3) *Third year class.* This group peaks on the graphs around 50-55 mm with a few members reaching 60 mm in length. The mean class length shifts slightly downward in September and November. Presumably this year

class fluctuates with the removal of older members by death and addition of new members from the second year class. If these interpretations are correct, *B. caribaeum* does not exceed four years of age in Old Tampa Bay.

It is evident from the histograms that the amphioxus population varied somewhat in its length classes from year to year between 1963 and 1967. Some of the variation may be credited to sampling procedures and some to environmental influences. A severe freeze or the actions of drastic storms like hurricanes (one occurred during the period of the study) are influential events in the life of the shallow water organism. After allowing for this annual variation, there still remains a general picture of spawning during the fall months and maturation of age groups during the remainder of the year.

Density Determinations

Attempts to obtain an accurate measure of density were not particularly successful. The number of animals per liter of sand varied from 0-15 depending on which portion of the sandbar was sampled. In an area four miles from my collecting site E. L. Pierce (1965) recorded an average of 183 specimens per liter in one series of dredge hauls. Boschung and Gunter (1962) estimate that *B. caribaeum* in Mississippi Sound seem to be numbered in billions. It is encouraging to encounter an organism that evidently is not threatened by man's use and misuse of the environment.

Summary

The amphioxus *Branchiostoma caribaeum* dwells in sandy areas of Old Tampa Bay in considerable numbers. The population spawns during the fall of the year. Sexual maturity is reached at about 30 mm in length. Length frequency data are interpreted as showing three age classes, namely: 1) less than one year old, specimens up to about 30 mm total length; 2) second year class, specimens 30-50 mm long; 3) third year class, 45-60 mm long.

Accurate density determinations were unsuccessful. The Bay appears to support large numbers of *Branchiostoma* in spite of intense human use of the area.

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